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BROOKLYN BOTANIC GARDEN
LEAFLETS

SERIES XI BROOKLYN, N.Y., APRIL 4, 1923. No. 1

GREGOR MENDEL

PIONEER INVESTIGATOR OF THE LAWS OF HEREDITY*

In the hall of fame, few names survive the ravages of Time. Few men achieve everlasting greatness. Our race and our generation are proud of their progress, their marvelous, complex, intricate civilization. Compared with the preceding centuries, we seem to have achieved wonders. Hence, we are prone to think, each of us, of how much *we* have evoluted individually as well as in the mass from our distant historic ancestors. But one wonders, if after all, the race as a whole has been responsible for much of this progress. How far would we have gone on the great long upward climb, if among us there had not been a comparatively few great minds, such as Dante, Shakespeare, Pasteur, Newton, Linneaus, Beethoven, Bacon, Rousseau, Darwin, Galton, Mendel, and the great religious teachers? Take several hundred or perhaps a thousand such immortals out of our history—obliterate their works and all that these have given rise to, and then ask yourself if mankind would be very different today from that time when mankind's deeds were first recorded on the walls of caves and carved on the tombs of stone. Trillions of human beings have passed but few have left any impress.

And of these few, Gregor Johann Mendel is to be counted as one. *Why?* Because to him, more than to anyone else we owe the foundation of the science of genetics—a science that involves the study of heredity, the determination of its laws and their application to man (eugenics) and to the breeding and improvement of domestic animals and cultivated plants. Just as the history of ancient Egypt remained a closed book until it was opened by the Frenchman, Champollion, through the aid of the Rosetta Stone with its Greek translation of the ancient script, so Mendel with a few garden peas and a brilliant, trained, analytical mind, discovered the two laws of heredity which bear his name—

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* This LEAFLET is in recognition of the one hundredth anniversary of the birth of Gregor Mendel, July 22, 1822, and is issued in connection with the Pasteur-Mendel program at the Brooklyn Botanic Garden, April 19, 1923.

laws that brought order out of what seemed hopeless chaos. In those "dark ages" when much nonsense and superstition passed as science, Balzac characterized "Heredity" as "a sort of maze in which science loses itself," and further on, he continues, "We will leave the solution of this problem also to the twentieth century, with that of the nomenclature of microscopic organisms, and our grandchildren will perhaps write as much more nonsense as our learned societies have already produced on this obscure question."

But the beginning of the twentieth century—in fact, the very first year—1900, saw the maze made intelligible and the mists and fog that had hung over this subject for centuries clear away. For in 1900, Mendel's laws were rediscovered, simultaneously, by three European botanists—Correns, Tschermak, and de Vries—while conducting experimental researches on plants independently, and unknown to each other. You may well ask how these laws, once discovered, were lost, and thereby hangs a romantic but semi-tragic story.

Mendel did his work and made his discoveries during our Civil War period, which was also the great controversial period on the doctrine of evolution. The crossing experiments with pea varieties covered a stretch of eight years. His results, conclusions and laws were published in 1866 in the comparatively unimportant, though widely distributed transactions of the local natural history society of Brünn,* having been read before the society on March 8, 1865. Charles Darwin, and his co-workers, in the midst of the intellectual revolution caused by the publication of the "Origin of Species" a few years previously, seem to have never seen Mendel's paper, although Darwin's views are recorded as one of the inciting causes which led Mendel to initiate his explorations in the field of heredity. Mendel's friend, Carl Nägeli, was one of the great authorities on heredity of that day, but Mendel's paper and letters to him regarding his views, seem to have made no impression on him, as he did not even mention him in his great work on heredity, published in 1884.

Interest apparently in this subject at the time was great, as evidenced by the French Academy offering a prize in 1861 (awarded in 1862) on "Studies of plant hybrids from the standpoint of their fertility and the perpetuation of their characters," and by the publication of Wichura's famous paper on "Willow hybrids" in 1865. In England, in 1864, this general subject was made the basis of a presidential address before one of the leading scientific societies, the material being drawn from the work of the French prize competitors. Yet in spite of all this interest and the wide circulation of the "Brünn Publication," Mendel's paper is only cited in the literature and bibliography lists twice previous to the rediscovery in 1900. These were Focke's *Die Pflanzen Mischlinge*

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* A copy of this original publication of Mendel's work may be found in the library of the Brooklyn Botanic Garden in "Verhandlungen des naturforschenden Vereines in Brünn." **4**: 3-47. 1866.

(Plant Hybrids), and L. H. Bailey's *Plant Breeding*. It is true, of course, that the work was in a sense buried, as are many such publications, in the transactions of a comparatively little-noticed society, the members of which were interested in all the phases of natural science. Once this volume was duly recorded in the hundred or more libraries to which it was sent and placed on the shelves in its proper sequence, it is doubtful if any but the most determined seeker after knowledge ever saw it, and these circumstances possibly account for its long oblivion and neglect. At any rate, Mendel never lived to see the world's appreciation of the value of his discoveries and deductions. In his later years, he is quoted as repeating "My time will surely come," but he had been dead 16 years before it arrived.

Mendel himself, were he alive today, would be amazed at the results of the work he initiated. Since 1900, thousands of papers in dozens of different tongues have been written embodying the results of multitudinous experiments, both on animals and plants, and the science of genetics that has arisen from the foundation stones he laid is permeated through and through with his methods and philosophy—so much so that most geneticists are in a large measure "Mendelianists."

Wealthy foundations have been accumulated to further genetic work. Statues and other memorials have been erected and founded in his honor, and in the city of Brünn, in the public square, beside the Königskloster, where Mendel had his experimental garden, did his work, and evolved his theories, is a marble statue of heroic size of the man himself, wrapped in his priestly robes, standing before a wall against which pea vines are clambering. On the base are depicted the kneeling forms of a man and woman, hands clasped to signify marriage and human heredity, and the words "To the Nature-Student P. Gregor Mendel, 1822-1884. Erected by the friends of science."

In this brief memorial paper, I have not told what Gregor Mendel's laws were, but they may be found enunciated in any modern textbook of biology, as they are studied by all students of biology in the various institutions of learning over the world. Further, the Brooklyn Botanic Garden has published in a former LEAFLET (Series VI, No. 2, 1918), a popular exposition of this subject under the title, *Environment, variation and the laws of heredity*.

Now, as to Mendel's life. His parents were Austrian, or more properly Moravian Germans, very poor, and his father belonged to the agricultural peasant class, holding his small tract of land by socage, i. e. performing agricultural labor (*Robot*) for a lord or nobleman. Those who have seen the play R. U. R. in New York, possibly recall that its author was a countryman of Mendel's, and hence will understand the source of the name Russum's Universal Robots. Mendel as a boy early became initiated into the mysteries of farming and fruit growing, was taught the grafting of fruit trees by his father, and no doubt had the thorough training in economic botany that is every farm boy's heritage, the world over. He was studious, and in spite of the family's poverty, had a good education, his younger sister voluntarily contributing part of her dowry for this purpose. This, Mendel afterwards repaid many times over. One of his early teachers was an Augustinian and through him, perhaps, Mendel entered the Königskloster or the cloister of St. Thomas, in Brünn. The cloister sent him to the University of Vienna, where he met Nägeli who was a teacher there and where he became a student of the entomologist, Kollar. There he studied mathematics, physics and the natural sciences, later returning to Brünn to teach science in the Realschule, where he appears to have been very successful in inspiring good work among his pupils. In 1868, three years after he read his now famous paper on hybridization, he was elected Prälat, or Abbot of the cloister. In addition to his researches on peas, he also worked with bees and the hawkweed (*Hieracium*). The data on bees have never been found. His last years were spent in bitterness and disappointment, and on January 6, 1884, he died of chronic nephritis. He, to a greater extent than any other man, has done more toward solving the problem of which Tennyson wrote:

> "Flower in the crannied wall,
> I pluck you out of the crannies,
> I hold you here, root and all, in my hand,
> Little flower—but if I could understand
> What you are, root and all, and all in all,
> I should know what God and man is."

ORLAND E. WHITE.

CALENDAR OF GARDEN EVENTS IN APRIL

April 6, Friday, 4 p.m. Motion Picture: "EVOLUTION."

April 8, Sunday, 4 p.m. Motion Picture: "EVOLUTION."

April 13, Friday, 4 p.m. Lecture: Trees in Nature and Art. Dr. A. F. Blakeslee, Resident Investigator in Plant Genetics, Station for Experimental Evolution, Cold Spring Harbor, L. I.

April 19, Thursday, 4 p.m. Pasteur-Mendel Celebration. Dr. G. M. Reed and Dr. O. E. White.

April 20, Friday, 4 p.m. Lecture: Forestry in the United States. Professor Henry Solon Graves, Dean, School of Forestry, Yale University.

April 27, Friday, 4 p.m. Lecture: What's New in the Garden. Mr. E. I. Farrington, Editor of Horticulture, Boston, Mass.

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CHILDREN'S NUMBER

BROOKLYN BOTANIC GARDEN

LEAFLETS

SERIES XI   BROOKLYN, N.Y., APRIL 18, 1923.   NO. 2

TENTH ANNUAL GARDEN EXHIBIT FOR BROOKLYN BOYS AND GIRLS

We are holding this fall our tenth annual Garden Exhibit for Brooklyn boys and girls. We hope that more schools than ever before will avail themselves of the privilege offered to exhibit with us. In order to accomplish this, changes have been made in the prize classes. Note that *Classes A* and *B* are for small-school exhibits: *Class A* for vegetable display, and *Class B* for flower display. In each class, the number of entries from a given school is limited. This plan makes it possible for the small school to compete and also for the large schools to enter material. Each competing school wins at least a recognition prize of one book from The Nature Library (Doubleday, Page & Co.).

Class A—**Small-School Display.** Vegetables. Conditions for this display are as follows: entries of not more than fifteen and not less than ten exhibits of vegetables only. FIRST PRIZE, a trophy to the school making the best display, to be held for a year only, or until won three times, when it becomes the permanent property of the winning school. SECOND PRIZE, Two books from The Nature Library. THIRD PRIZE, One book from The Nature Library.

Class B—**Small-School Display.** Flowers and potted plants. Conditions are as follows: from ten to fifteen exhibits of flowers or potted plants. FIRST PRIZE, a loving cup, to be competed for under the same conditions as the trophy in *Class A*. SECOND PRIZE, Two books from The Nature Library. THIRD PRIZE, One book from The Nature Library.

Class C—**Box Display.** This display will consist of six sample window boxes from each school entering *Class C*. FIRST PRIZE in this exhibit is a beautiful loving cup. SECOND PRIZE, Two books from The Nature Library. THIRD PRIZE, One book from The Nature Library.

Class D—**Flowers.** This is a class for individual competition, and in which first and second prizes are offered. In this and the following classes the FIRST PRIZES are gold medals; SECOND PRIZES, bronze medals. Certificates of honorable mention will be given as THIRD PRIZES. If a boy or girl enters an individual class, he must understand that these same products cannot count toward his school display. Double entries should be made in such cases. Do not forget this. If you enter zinnias for an individual prize and wish to add zinnias to the school display, then you must bring two bunches of zinnias. The divisions in *Class D* are as follows:—

No. 1. Ageratum
Best 4 sprays
No. 2. Alyssum
Best plant (potted)
No. 3. Asters, blue
Best collection of 10
No. 4. Asters, pink
Best collection of 10
No. 5. Asters, white
Best collection of 10
No. 6. Asters, mixed
Best collection of 12
No. 7. Asters
Best plant (potted)
No. 8. Calendula
Best collection of 8
No. 9. Cornflower
Best collection of 12
No. 10. Dianthus
Best collection of 10
No. 11. Marigold
(Giant African)
Best collection of 12
No. 12. Marigold
(Dwarf French)
Best collection of 12
No. 13. Marigold
Best Plant (potted)
No. 14. Nasturtium
Best collection of 12
No. 15. Phlox
Best collection of 8
No. 16. Sunflower
Largest flower
No. 17. Verbena
Best collection of 10
No. 18. Zinnia
Best collection of 10

Class E—**Vegetables.** Surely this ought to be a popular class this year. Plan ahead so your vegetables will be in their prime at exhibit time. Try to send in perfect specimens. If, for example, you are exhibiting under No. 17, red tomatoes, have your eight tomatoes as nearly the same size as possible. Wash your vegetables carefully, so that they make an attractive appearance. First prizes in this class are gold medals; second prizes, bronze medals; third prizes, certificates of honorable mention.

Divisions in Class E

No. 1. Beans, bush
Best pint, shelled
No. 2. Beans
Best quart, unshelled
No. 3. Beets
Best bunch of 6
No. 4. Carrots
Best bunch of 5
No. 5. Cabbage
Best head
No. 6. Corn
Best 6 ears
No. 7. Egg-plant
Best 2
No. 8. Kohlrabi
Best 4
No. 9. Lettuce
Best 2 heads
(roots and all)
No. 10. Onions
Best 4
No. 11. Peppers
Best 4
No. 12. Potatoes
Best 6
No. 13. Pumpkin
Best specimen
No. 14. Radishes
Best 8
No. 15. Squash
Best specimen
No. 16. Tomatoes, green
Best 8
No. 17. Tomatoes, red
Best 8
No. 18. Tomatoes
Small-fruited varieties
Best 10

Class F—**Best Special Plant.** Any plant cared for by the exhibitor may be entered. The plant may be a geranium raised from a cutting, an aster from a seed, a fern from a runner—it matters not so long as the work is yours. The plant stands no chance of prize winning if it is not in good condition, clean, properly potted, and free from insect pests. FIRST PRIZE, a gold medal; SECOND PRIZE, a bronze medal; THIRD PRIZE, a certificate of honorable mention.

Class G—**Best Bunch of Flowers.** Judged on perfection of the flowers and taste in arrangement. FIRST PRIZE in this class is a gold medal; SECOND PRIZE, a bronze medal; THIRD PRIZE, a certificate of honorable mention.

Class H—**Individual Garden Display.** The greatest variety of flowers or vegetables raised by one child constitutes this display. Here is an opportunity to show some originality and taste in the way you put together and arrange your own exhibit. Let us have more exhibits in this class this year. FIRST PRIZE, a gold medal; SECOND PRIZE, a bronze medal; THIRD PRIZE, a certificate of honorable mention.

Class I—**Weed Display.** This weed exhibit may be one of either fresh or pressed specimens. No exhibit can take a prize unless the specimens are carefully and correctly named. If you go away to the country in the summer you will have a good opportunity to make a large collection of weeds and wild flowers for the exhibit. FIRST PRIZE, a gold medal; SECOND PRIZE, a bronze medal; and certificates of honorable mention will be awarded to those taking third places.

Class J—**Wild Flowers.** Similar to *Class I.* FIRST PRIZE, a gold medal; SECOND PRIZE, a bronze medal; THIRD PRIZE, certificates of honorable mention.

Note.—No individual may carry off more than one first and one second prize in *Classes D* to *J* inclusive.

Class K—**Composition.** FIRST PRIZE, Two books from The Nature Library will be presented to the boy or girl handing in the best composition of not more than one thousand words on the subject, "Our Brooklyn Botanic Garden." One book from The Nature Library is the SECOND PRIZE for the second best composition on the same subject.

MISCELLANEOUS DETAILS FOR ENTRIES

Time—The tenth annual Garden Exhibit for the boys and girls of Brooklyn will be held September 28th and 29th. The exhibit will be open to the public from 2 to 5 p. m. on the 28th, and from 10 a. m. to 4 p. m. on Saturday the 29th.

Place—The exhibit will be held in the central rotunda of the laboratory building, at the Botanic Garden. The building may be entered either from Washington Avenue, No. 978, or from the Garden side.

Conditions of Entry—Be sure that each separate exhibit, unless it be a part of the class or school exhibit, has an entry card with the exhibitor's name, school, and address upon it. These entry cards may be had from us in early September, and should be filled in exactly as indicated. Bring the exhibits to the Botanic Garden on September 28th, between 8 a. m. and 12 m.

Time of Judging—Three expert judges will judge these exhibits and make public their decisions on September 28th at 2 p. m.

Prizes—We offer for second prizes in *Classes A*, *B* and *C*, books from The Nature Library (Doubleday Page & Co.), those large and valuable nature books which mean so much to schools. The school winning a second prize may choose those books from The Nature Library which it most desires. In this way, year after year, whole sets may be built up in the schools. We are still offering trophies as first prizes.

Removal of Exhibits—Exhibits may be taken away by the exhibitors at 4 p. m. on September 29, or at any time before October 3.

Presentation of Prizes—Prizes, both individual and group, will be presented on October 13, at 2:30 p. m., in the auditorium of the Brooklyn Botanic Garden building. No prize winner will receive his prize unless he is present, or sends a substitute, on October 13.

ELLEN EDDY SHAW,
Curator of Elementary Instruction.

Note.—Competitors under *Classes A*, *B* and *C* should ascertain their allotted exhibit space by September 17, from Miss Maude L. Hickok, who has general charge of the exhibit.

SPRING DOCENTRY

To assist visitors in studying the collections, a docent will leave the front door of the laboratory building every Monday, Wednesday, and Friday (weather permitting) at 3 p.m., beginning Wednesday, May 2, as per the following schedule:

Monday	Japanese Garden Wild Flower Garden
Wednesday . .	Rock Garden Conservatories
Friday	Herbaceous and Shrub Garden Ecological Garden

This service is offered to the public without charge. No parties of less than ten adults will be conducted. Children must be accompanied by an adult. *Members of the Botanic Garden, and friends accompanied by members*, may receive docentry service at times other than those specified above. Special arrangement should be made as far in advance as possible with the Curator of Public Instruction.

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BROOKLYN BOTANIC GARDEN

LEAFLETS

SERIES XI BROOKLYN, N.Y., MAY 2, 1923. Nos. 3 and 4

LOUIS PASTEUR

(1822 - 1895)

The interval of ten years centering around 1860 was the turning point between the old and the new in Biology. In 1859, Charles Darwin, after many years of observation and study, published "The Origin of Species," a book destined to throw a flood of light on the whole realm of human thought. In 1866, Gregor Mendel published his paper on inheritance in peas, which, although it was rejected by an unenlightened generation, has proved to be the keystone of genetical investigation in the early twentieth century. Anton de Bary, in 1865, demonstrated the fact that wheat rust requires two hosts—wheat and barberry—in order to complete its life cycle, and this, together with his other studies, laid the foundations for plant pathology. Joseph Lister, in 1867, gave conclusive demonstration of his method of antiseptic surgery which banished the horrors of hospital diseases from the minds of men.

It was during this period that Louis Pasteur began to "blaze luminous trails in the world of the infinitely little." His studies have contributed tremendously to our knowledge of the vital activities of the invisible world about us, illuminating the domain of micro-organisms, opening up new vistas in the field of fermentation and the causation of animal and human disease, and founding the new science of Microbiology.

Pasteur was born December 27, 1822. He came from a sturdy race of the common people. His father was a tanner who served as a conscript under Napoleon in Spain, and, in later life, looked back upon the Napoleonic era as the "Golden Age." He was a silent man, industrious, unselfish, devout. Pasteur's mother was the daughter of a gardener, an affectionate, lovable, enthusiastic woman. His parents, although poor, sacrificed to give their son a good education. He attended school at Arbois, Besançon, and later the École normale at Paris. He was not a brilliant student, but he was serious-minded and persistent. Throughout life he manifested his affectionate regard for his parents and acknowledged his debt to them.

It was in the field of chemistry and physics that Pasteur made his first discoveries, having become interested in the study of tartaric acid and related subtances, with particular reference to molecular dissymmetry. These researches won him recognition as a skilful investigator. It was in 1856 that he first turned his attention to the study of fermentations, and in 1857 he published his paper on the lactic acid fermentation, which occurs in the souring of milk, demonstrating that the formation of the acid is is due to living microscopic rods.

The bacteria had been first observed in 1675 by Leeuwenhoek, a linen weaver and a grinder of lenses. Although the compound microscope had been invented in 1590, it was still a toy and useless for scientific discovery. Leeuwenhoek was an expert maker of simple lenses or magnifying glasses, with a magnifying power varying from 40 to 160 diameters. With these instruments he examined a large number of natural objects. He was the first to observe the corpuscles in the blood of man, tadpoles, fish, etc., and correctly described their shape. He also observed the circulation of the blood in the capillaries and thus completed the work of Harvey on the circulation of the blood in the higher animals.

The bacteria were first seen in a drop of rain water. Leeuwenhoek then examined various substances for the presence of what he considered animal life in its most minute form. It was in 1683 that his first complete description of bacteria appeared. He states: "I saw with great astonishment, especially in the material mentioned, that there were many extremely small animals which move about in the most amusing fashion. The largest of these showed the liveliest and most active motion, moving through rain water or saliva like a fish of prey darts through the water. This form, though few in numbers, was met with everywhere. A second form moved around often in a circle, or a kind of curve. These were present in large numbers. The form of a third kind I could not distinguish clearly. Sometimes it appeared oblong, sometimes quite round. They were very tiny, in addition to which they moved so rapidly that they tore through one another. They presented an appearance like a swarm of flies buzzing in and out between one another."

The history of Microbiology may be divided roughly into two periods — the first extending from the date of discovery of bacteria to 1860, and the second beginning with the latter date. The early period was largely one of philosophical speculation, oratorical discussion and polemic dispute, centering around three great doctrines — the spontaneous origin of life, the nature of fermentation and putrefaction, and the nature of disease. To some extent experiments were carried out, but for the most part they were designed to demonstrate the accepted beliefs of the experimenter, rather than to bring to light scientific facts.

The doctrine of the spontaneous origin of life was generally accepted, although in our day it is difficult to understand the common belief in the spontaneous appearance of new organisms. Earlier it was even accepted for the higher forms of life — the spontaneous origin of mice from grain and old rags, snakes from horsehairs, flies from decomposing meat. Simple experiments, however, demonstrated the absurdity of such notions, but the discovery of micro-organisms and their ubiquity afforded a fertile field for a "happy concourse of atoms," chained together by the action of natural forces, giving rise to molecules of living matter, without contact or close association with living substance.

Pasteur (1860-1864) devised a number of ingenious experiments which had a bearing upon this doctrine of spontaneous generation. He came to the conclusion that all life comes from preexisting life, and that all germs have parents similar to themselves. His experiments aroused intense opposition, and controversies occurred between him and the upholders of the doctrine of spontaneous generation. Pasteur, however, arrived at his conclusions by the use of pure cultures of micro-organisms. He was able to sterilize by boiling the various infusions which he used and, unless he transferred to the sterile flask a drop of substance containing organisms, the infusions kept indefinitely. But the transfer of an organism to the infusion at once led to characteristic changes.

A second theory which was discussed during the early period of Microbiology was the germ theory of fermentation. In many ways this doctrine was the exact opposite of the theory of spontaneous generation. According to the latter, organic substances spontaneously decomposed, and life originated during the process. According to the former, living organisms, by their growth and development, caused the decomposition. In general, this germ theory was rejected but there were a few who regarded the germs as causative agents of the chemical changes, and various experiments had been carried out by a large number of workers, all of which had more or less bearing upon the doctrine.

The most familiar fermentation was the change of sugar into alcohol and carbon dioxide, and numerous studies had shown the association of the yeast plant with the chemical change, although the exact relation between the organism and the change was obscure. Most students believed that the fermentation was a purely chemical process in which the molecules of sugar spontaneously decomposed and the yeast was merely an accidental occurrence, or even originated in this process. This view was greatly strengthened by the chemist Liebig, who ridiculed the whole notion that yeast might cause such profound chemical changes. Liebig stated that any attempt to explain the putrefaction of animal substances by the presence of animalcules was as absurd as the belief of the child who imagines he can explain the rapidity of the flow of the river Rhine by the agitation caused by the water wheels of Mainz. He raised the question whether we can regard plants and animals as the means whereby other organisms are destroyed, when their own bodies are likewise condemned to undergo the same series of putrefaction. If the fungus is the agent of the oak's destruction, if the microscopic animalcule causes the putrefaction of the elephant's carcass, what is the agent which brings about the putrefaction of the fungus and the microscopic animalcule when they have ceased to live?

Pasteur (1855-1859) contributed greatly to establishing the doctrine that fermentation is the result of the activities of living organisms. He first studied the lactic acid fermentation and succeeded in demonstrating very clearly that a specific bacterial rod was associated with the change of the sugar into the lactic acid. These studies were followed by experiments with the alcoholic fermentation in which the true rôle of the yeast as the agent in the transformation was demonstrated. Still later he studied the butyric acid fermentation and in this connection discovered anaerobic life. It had been assumed that free oxygen was absolutely essential for every living organism. Pasteur demonstrated that the butyric acid organism was prevented from growing in the presence of ordinary air, and thrived only in the presence of very minute traces of free oxygen.

These researches led to far-reaching results in his later studies on the injurious changes in wine and beer, the distribution of germs in the air, and especially in the development of technique and the origination of the process of Pasteurization. Of great significance was the application made by Lister in his method of antiseptic surgery, a method made possible with the acceptance of the doctrine of microbial causation of fermentation and putrefaction.

Lister, like all surgeons at that period, was thoroughly familiar with the so-called hospital diseases—erysipelas, pyemia, septicemia and hospital gangrene. Very few hospitals in those days were ever entirely free from these diseases, which frequently occurred in epidemic form, and the only remedy was the closing of the hospital. Many records have been made regarding the prevalence of hospital diseases. The average mortality from operations for amputations in England was 25 per cent. The mortality in the hospitals of Paris was greater than in those of England—about 60 per cent. So prevalent and so high in mortality were these diseases that Sir James Simpson asserted that the man laid on the operating table in one of our surgical hospitals was exposed to more chance of death than the English soldier on the field at Waterloo. Great were the risks involved in entering a hospital, so that we see why the field of surgery in those days was so limited. Surgeons spoke of periods of good luck as being certain to be followed by times of disaster.

The similarity of fermentation and putrefaction to disease phenomena in animals was long familiar. The demonstration of the germ origin of the former led to the establishment of a similar connection between germs and disease, and in this field of biological inquiry Pasteur made some of his most striking triumphs. His first studies (1865-1870) were connected with maladies of silk worms, [the cultivation of which had become an important and lucrative industry. About six weeks elapsed between the hatching of the eggs and the carrying of the cocoons to the market. This was a period of joyous festivity, in spite of the hard labor which it imposed. The mulberry tree was called "arbor d'or" from the populations that lived upon it. By 1865 the silk culture was threatened with complete ruin by an inexplicable malady which attacked the worms in all stages of development. This disease was characterized by the appearance of small spots or corpuscles resembling grains of black pepper, which led to the descriptive name "pebrine." The loss in 1865 amounted to 100,000,000 francs. All the "seed" or eggs from every part of Europe and even China were likely to be contaminated; only Japan afforded healthy "seed." Pasteur, although he had never previously touched a silkworm, spent six years in unravelling the mysteries of the plague. He found not one disease, but two, and discovered effective means of control, which, when applied, speedily restored the industry.

Beginning with 1876, Pasteur took up his studies of the diseases of higher animals and man. It is interesting to note that Robert Koch in this year established the definite connection between the anthrax organism and anthrax in the lower animals, completing the chain of evidence which was being welded by various workers during the previous decades. The important question had been raised, however, as to whether the anthrax organism was actually the cause, or whether anthrax was also a virus disease—"virus" being some obscure or unknown agent in the causation of diseases. It was with this question that Pasteur was first engaged, and by means of brilliant experiments with pure cultures he was able to clearly show that the organism itself was actually the causative agent. He also worked out the true rôle of the anthrax spores in perpetuating the organism over long periods in the soil.

Pasteur next took up the study of chicken cholera. He had been studying this disease for some time and had a number of cultures in his laboratory. He went away on vacation and upon his return a few weeks later he again took up his studies. To his surprise he found that his old cultures would no longer cause death in fowls. "Chance favors only those who are prepared to take advantage of it." Pasteur obtained fresh cultures and inoculated them into the same birds which he had previously inoculated with the old cultures. He was even more surprised to discover that these virulent cultures were without marked effect, although they quickly killed fowls not previously used. These experiments, extended and perfected, constitute his first brilliant discovery in vaccination—a method of prevention of disease which had been first developed by Jenner in 1798 for smallpox.

The discovery of the method of vaccination for chicken cholera opened up a new field which Pasteur intensively explored. His next efforts were connected with finding a method of vaccination for anthrax; and he made the interesting discovery that if the anthrax organism is grown at a temperature of about 43°C, or 6° above the optimum for its growth, it loses its power of producing disease. Thus, by growing the organism at this higher temperature for longer or shorter periods, he was able to vary its virulence and to prepare vaccines for use in protecting animals against a virulent culture.

Pasteur's treatment for rabies stands out in the popular mind as the greatest of his achievements. This disease, on account of its attendant suffering and almost certain fatal ending, had long been the terror of people bitten by a mad dog. Pasteur, during the years 1882-1886, perfected a method of treatment which, in essentials, is widely used in all parts of the world at the present time.

Pasteur's life was one of tremendous activity. Handicapped by a paralytic stroke in 1868, his indomitable will and unquenchable desire for knowledge obtained by experiment, carried him to achievements attained by no other. He never hesitated to fight valiantly for his views, rigidly supported by experimental data. Dramatic are such episodes in his life as his controversy with Pouchet and Bastian on spontaneous generation, with Frémy and others regarding fermentation, and with the medical men with reference to the true nature of disease. Witness his public demonstration of the effectiveness of his method for vaccination against anthrax, when he accepted the challenge of his opponents and vaccinated 25 sheep, and then inoculated these 25 vaccinated animals and 25 unvaccinated with a virulent culture of the anthrax bacillus, stating positively that on a certain day all the vaccinated would be alive and the unvaccinated dead. His prediction was fulfilled. What boundless faith in the results of his experimental methods!

Pasteur did not always succeed at the first attempt. Sometimes he was diverted from the right track or secured only a partial insight into the solution of a problem. Occasionally he was utterly discouraged. After working for two years on the silkworm problem he enters his laboratory, throws himself down into a chair and exclaims to Duclaux and his other assistants—"We have failed. Everthing must be done over. There are two diseases!" Incessant toil was the keynote of his success. Madame Pasteur writes to her daughter in 1884, "Your father is absorbed in his thoughts, talks little, sleeps little, rises at dawn, and, in one word, continues the life I began with him this day thirty-five years ago." Pasteur did much of his work with the aid of assistants. His accomplishments would otherwise have been impossible. His best collaborator was the faithful wife, subordinating her life to the scientific interests of her husband who fulfilled his pre-marriage promise, "I will make you known to posterity."

Pasteur's discoveries revealed a wonderful world of unlimited possibilities. He wrote: "It is within man's power to rid the world of parasitic diseases, if, as I believe, the doctrine of spontaneous generation is false." Men may not succeed in the complete attainment of his glorious vision; however, remarkable triumphs have been obtained, for example, in smallpox, yellow-fever, and hospital diseases. We can hardly imagine what the result would be if known scientific facts were effectively applied in human affairs.

Pasteur was highly honored by his contemporaries. Although he had numerous opponents in his scientific progress, he was also supported loyally by faithful friends. He was made a member of the Académie des Sciences in 1862, of the Académie de Medicine in 1873, and of the Académie Française in 1882. He held important professorships at Dijon, Strasbourg, Lille, École normale and the Sorbonne. He was relieved from his duties as a professor in 1874: this was made possible by a life annuity of 12,000 francs by the French government, increased to 25,000 francs in 1884.

In 1888 L'Institut Pasteur was established in Paris, most of the money contributed by private subscription; the architect, contractors and workmen in part donating their services to the erection of the laboratories. Thus were furnished facilities for the intensive study of human and animal disease and methods of control.

In 1892 the 70th jubilee of Pasteur's birth was held in Paris, attended by officials of the French government, and scientific men from the entire world. Most unique, perhaps, was the tribute of Joseph Lister:

"Your researches upon fermentations have thrown a powerful light which has illuminated the baleful darkness of surgery and has changed the treatment of wounds from an uncertain and too often disastrous empirical affair into a sure beneficent scientific art. Thanks to you, surgery has undergone a complete revolution which has robbed it of its terrors, and has enlarged almost without limit its efficacious power. Medicine owes not less than surgery to your profound and philosophical studies. You have lifted the veil which had covered infectious diseases during the centuries; you have discovered and demonstrated their microbial nature. Thanks to your initiative and, in many cases, to your own special work, there are already a large number of these pernicious maladies of which we know completely the causes."

Numerous statues commemorating Pasteur have been erected in several cities of France. At Alais there is a fine one recalling his investigations on the diseases of silkworms. Pasteur is represented by a full figure, holding in his left hand a branch of the mulberry on which are present the cocoons of the silk worm moth. At Melun the bust of Pasteur crowns the statue, a shepherdess placing before it a wreath. His work on anthrax is recalled by a fine statue at Chartres, an excellent bas-relief commemorating the work of Pasteur and his assistants, Chamberland, Roux and Boutet, in connection with the vaccination of sheep against this scourge. An excellent statue at Lille commemorates his work on fermentation, the bas-reliefs showing his studies on fermentation, antirabic injection, and vaccination against anthrax. At Arbois, Besançon, Dole, and Paris, statues remind the observer of his triumphs over rabies and other diseases. In May of this year a memorial will be dedicated at Strasbourg, the scene of Pasteur's early activities as professor of chemistry, in connection with a centenary celebration of his work.

Some aphorisms of Pasteur are characteristic:

"Chance favors only those who are prepared to take advantage of it." "Science should not concern itself in any way with the philosophical consequences of its discoveries." The characteristic of a true theory is its fruitfulness." "It would seem to me that I was committing a theft if I were to let one day go by without doing some work." "Whatever career you may embrace, look up to an exalted goal; worship great men and great things."

Pasteur passed away on September 28, 1895. A state funeral was held in his honor, and his body was temporarily placed in one of the chapels of Notre Dame. A beautiful chapel, modelled after the tomb of Galla Placidia at Ravenna, was prepared for him within the precincts of L'Institut Pasteur, and over the entrance these words of his are inscribed: "Heureux celui qui porte en soi un dieu, un idéal de beauté et qui lui obéit: idéal de l'art, idéal de la science, idéal de la patrie, idéal des vertus de l'Evangile." Here he was finally laid to rest in January, 1896, with appropriate ceremony, at which Lister was present and paid this tribute to his memory: "Four years ago, on the occasion of the jubilee of Monsieur Pasteur, I had the supreme honor to present to him, in the name of Medicine and Surgery of the entire world, the homage of their recognition. Today I assist at his funeral! This ceremony is noble and imposing, worthy of the memory of our revered master. But it fills us with a profound sadness, since it recalls to us that this great light of science, so bright and so clear, is extinguished: that this character, so noble and so lovable, has disappeared from our world."

Where he labored, there he rests—his achievements and genius the inspiration of many investigators in all phases of microbiology, "the world of the infinitely little."

George M. Reed.

To Reach the Garden take Flatbush Avenue trolley to Empire Boulevard (Malbone Street); Franklin Avenue and Lorimer Street trolleys to Washington Avenue; St. John's Place trolley to Sterling Place and Washington Avenue; Ninth Avenue, Union Street, Vanderbilt Avenue, and Smith Street trolleys to Prospect Park Plaza and Union Street; Brighton Beach Express, Broadway (B.R.T.) Subway to Prospect Park Station, north exit; Interborough Subway to Eastern Parkway-Brooklyn Museum Station (east exit).

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BROOKLYN BOTANIC GARDEN

LEAFLETS

SERIES XI BROOKLYN, N. Y., MAY 30, 1923. NO. 5

WILD PLANT CONSERVATION IN CONNECTICUT, A SUBURBAN STATE[1]

The problems of wild plant conservation vary according to the type of region concerned. Vermont's, as discussed in a previous article,[2] was one of a rural state threatened with the depletion if not the extinction of the rarities of its forests and mountains through their exploitation by commercial collectors of living plants. According to reports which have come to me, the Vermont "game law" of 1921 has already accomplished the desired result of restricting the activities of the collectors. Enforcement could be directed against a few known individuals, and was therefore comparatively simple. It will be interesting now to watch the progress of natural restocking.

In Connecticut, however, the problem is that of a state with a large urban and suburban population. Connecticut has its wild places, notably in Litchfield and Windham counties, but, on the whole, its problems are different from those of Vermont. Connecticut is predominantly settled; its wildness is a matter of hills and woods; Vermont's is that of forests and mountains. Connecticut is in easy automobile radius of New York and Boston; a large region is inhabited by New York commuters. The dangers to wild plant life in Connecticut are correlated with its character as a residential and industrial state, a state of extensive automobile traffic.

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[1] Reprinted from AMERICAN FERN JOURNAL, Vol. 13, No. 2, 1923.

[2] Game laws for ferns and wild flowers, Am. Fern Journal 12: 33–45.

It has passed practically beyond the stage where it is an important source of living plants of rare wild species for the commercial plant trade. Such rarities as it has, like the mountain spleenwort, the lip fern, the climbing fern, etc., occur perhaps in single localities, guarded by their very rarity from the commercial collector. They should, of course, be given every possible protection, if feasible, in sanctuaries like the one at Fairfield.

Connecticut's main problem, however, may be said to be typified in the protection of its state flower, the laurel. It has a law relating to the laurel, as well as to the climbing fern. Indeed, Connecticut deserves recognition as the pioneer state in the development of game laws for plants. (See appendix to this article.) But in the case of the laurel, as with the flowering dogwood, we are faced with a condition which laws alone will not remedy. We cannot as wild plant conservationists sit back satisfied merely to try to *restrict* the enjoyment of wild beauty like that of the laurel to those able to maintain an estate, or to those able to travel far by automobile, or visit in some favored region.

A state flower should be available to all. Nature produces laurel rather abundantly. Let man learn how, and then raise it in large plantations for commercial use. Surely there should be someone in Connecticut interested enough in its state flower to back the experimental study of its propagation, either at the State Agricultural College or under private auspices. If we make the raising of laurel from seed as simple as raising rosebushes, it should be possible to repopulate the roadsides with laurel as the railroad company has planted its embankments with climbing roses. Why not a state laurel nursery as well as a pine nursery, or a fish hatchery for the free supply of small game fish? The laurel of some quiet pasture or valley is one of the strongest memory bonds of the Connecticut visitor or descendant. Grow it for export. Fill the cities in

June with its wonderful bloom. Produce all that New York will take. Give this American plant a chance to take its rightful place as the peer of any of the florist's present stock.

Education in the enjoyment of the beauties of nature, constructive study of how to make these beauties more widely available, the protection in sanctuaries and by legal restrictions as far as needed of such plants as are so rare and difficult to grow as to render them liable to extinction: these, it seems to me, constitute the specific lines of action needed in Connecticut.

R. C. BENEDICT.

APPENDIX. CONNECTICUT STATUTES RELATINO TO THE CONSERVATION OF WILD PLANTS.

GENERAL STATUTES, 1918, § 6274. WILFUL INJURY TO STRUCTURES, TREES, VEGETABLES, AND OTHER PROPERTY. Every person who shall wilfully injure any tree or shrub standing upon the land of another, or injure or throw down any fence, trellis, framework or structure on the land of another, or shall wilfully cut, destroy or take away from the land of another, any creeping fern, crops, shrub, fruit or vegetable production, shall be fined not more than one hundred dollars or imprisoned not more than twelve months or both.

PUBLIC ACTS, 1921, CH. 270. EVERGREEN TREES, FOLIAOE AND TRANSPORTATION OF THE SAME.

SECTION 1. Any person who shall take from the land of another in this state the whole or part of any pine, spruce, hemlock, fir or other evergreen tree with needle-bearing branches thereon without having in his possession or having filed with the town clerk of the town wherein such land is situated the written permission of the land owner or his agent to take the whole or any part of any such tree, or who shall transport any such tree in such condition which is not marked as provided by section two of this act shall be deemed to have violated the provisions of this act.

SECTION 2. Section 6275 of the general statues as amended by chapter 285 of the public acts of 1919 is amended to read as follows:—Any person who shall take any Kalmia latifolia, commonly known as mountain laurel, or any ferns, vines or foliage branches of trees or shrubs from the land of another, to be sold or offered for sale as a commodity, without having obtained and filed with the town clerk of the town in which the land is situated, the written permission of the owner or lessee, or his duly authorized agent, of the land whereon the same was taken, shall be fined not less than fifty dollars nor more than one hundred dollars in each case, and one-half the amount collected as a fine shall be paid to the person upon whose information the proceedings were instituted. The owner, occupant or person in charge of the land as such authorized agent, or such person as he may command to assist him, may arrest any person violating any provision of this section, and forthwith take such person before some proper authority, who shall, upon complaint of the prosecuting officer try such person. The owner, occupant, person or agent in charge of the land, arresting any person pursuant to the provisions of this section shall be entitled to the fees allowed by section 2252 of the general statutes to constables for similar services, which fees shall be taxed as costs by the court before which the trial is had. Every bale, box, package or load containing more than twenty pounds of Kalmia latifolia or any ferns, vines or foliage branches taken from the land of another transported upon the highway or offered for transportation to any common carrier shall be legibly marked by tag, stencil or otherwise to indicate the name and address of the owner or lessee of the land from which such foliage was taken, and the name and address of the person who gathered the same. The presence in transit, either upon the highway or in the possession of any common carrier, of any such bale, box or package not so marked, shall be prima facie evidence of a violation of the provisions of this section by the person who gathered the contents of such bale, box or package. Any tree warden or officer authorized to serve criminal process may enforce the provisions of this section and may inspect and weigh any bale, box or package containing such foliage, but the provisions of this section shall not be construed as authorizing any officer to stop or impede the progress of any train or electric car of any common carrier upon which such foliage may be in transit. No provision of this act shall be construed to apply to any tree, shrub or plant in transit from or growing in any commercial nursery.

GENERAL STATUTES, 1918, § 6276. WILFUL DESTRUCTION OF TRAILING ARBUTUS. Every person who shall wilfully destroy, pull up, tear up, or dig up, any trailing arbutus from the land of another, or who shall sell, expose for sale, or purchase, or have in his possession, any trailing arbutus with the roots or underground stems attached, taken from land not owned or occupied by him, shall be fined not more than twenty dollars.

NOTICES

The Garden is open free to the public daily, from 8 am. until dark; on Sundays and holidays from 10 a.m. until dark. The Laboratory Building, containing the library, herbarium, and offices, is open daily (except Sundays), from 9 a. m. until 5 p. m. (Saturdays, 9–12). The Conservatories are open April 1–October 1, 10 a. m.–4:30 p. m. (Sundays, 2–4:30); October 1–April 1, 10 a. m.–4 p. m. (Sundays, 2–4).

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BROOKLYN BOTANIC GARDEN

LEAFLETS

SERIES XI BROOKLYN, N.Y., JUNE 13, 1923. NO. 6

THE ROCK GARDEN*

The Rock Garden of the Brooklyn Botanic Garden was constructed in the spring of 1916. The rocks are, for the most part, glacial boulders which were uncovered in the course of grading operations on other parts of the grounds. These boulders were very unprepossessing material for the construction of a rock garden, their rounded contours almost prohibiting any natural and artistic effects from being obtained. Their hard, impervious surfaces are far from ideal from the standpoint of the cultural requirement of the alpine plants, which revel in rocks of a rough, porous nature to which their roots may cling. In spite of these disadvantages, one is cheered by overhearing visitors commenting on the "wildness" and natural appearance of the garden. The fact that in 1918 over six hundred species and varieties were growing in the garden, many of them alpines considered very intractable in this part of the country, is testimony that the difficulties of cultivation have, in part, been overcome. A census has not been taken of the plants in the rock garden since 1918, but in all probability the number of species represented is just as large today in spite of losses due to vandalism, carelessness on the part of visitors, and lack of adaptability to our conditions on the part of some of the alpines. In order to provide quarters for plants that delight in rock crevices, a number of the larger boulders were split and the fissures filled with suitable soil. That all of these crevices are not occupied with happily thriving plants is partly due to the "taking" propensities of some of our visitors, who remove the plants almost as fast as they are set out.

What is known in garden parlance as a "moraine garden" was constructed in 1917 to care for some of the more capricious alpines. It was made by excavating the soil over a small area of the rock garden to a depth of eighteen inches or two feet, and replacing it with a mixture of three-quarter inch crushed stone, five parts ; sand, one part; and leaf mould, one part. This provides perfect drainage, and encourages the roots to penetrate deeply where it is cool and moist, a most important point in the cultivation of alpines. It also insures perfect ripening of the top growth, enabling the plants better to withstand the vagaries of our winters. Among the subjects planted in the moraine are *Androsace*, *Saxi-*

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* This LEAFLET is a reprint, with revision and additions, of Series VII, No. 3, 1919.

fraga, *Primula*, and *Asperula*. Their growth has been so encouraging that in the fall of 1922 a further area was excavated, more than trebling the size of the moraine.

The general idea in constructing the garden was that of representing a boulder-strewn slope. This design, of necessity, was modified in places to provide proper cultural conditions as to drainage, depth of soil, and shade. The desirability of walks or trails, so that visitors might get near enough to the plants (some of which are very diminutive) to appreciate their beauty, was another factor which prevented the idea of a boulder-strewn slope being carried out in its entirety. The provision of adequate facilities in the way of paths in a rock garden which is open to the public is always a problem when a naturalistic effect is desired. If the walks and trails are constructed of rocks similar in character to those used in the body of the garden, and made without definite boundaries so as to merge into the garden, many plants are doomed to destruction by the feet of visitors, particularly small and active boys, who wander from the straight and narrow way. The problem was partly solved in the Royal Gardens, Kew, England, by constructing the rock garden in the simulation of the bed and banks of a dried-up Pyrenean mountain stream. The bed of the stream is represented by a wide gravel path. Even with this arrangement, some of the plants on the higher parts of the garden cannot be seen readily from the walk, and it is no uncommon sight to see visitors armed with field glasses studying the plants and labels on the higher levels. Is it too much to hope that some day the people of Brooklyn may become imbued with such a love for plants that, instead of walking over, injuring, and sometimes destroying the plants that lie between them and the object of their interest, they will have recourse to field glasses? Bird lovers habitually use them. Why should not their use be extended to the flower lover?

As it was decided that the accessibility of the plants to the public was of greater importance than maintaining intact the ideal of a stony slope, our garden is well provided with walks and trails. These are made of irregular flag stones, laid informally, and, in the case of the small trails, with a stepping-stone effect. There is very little excuse for deserting the walks for the purpose of inspecting the plants—that is, unless one is so unfortunate as to be very near-sighted.

The rock garden is intended primarily to supply proper cultural conditions and to display in a suitable setting alpine and saxatile plants, and may thus be considered as an ecological exhibit. With this in mind, the garden was located opposite and adjacent to the Ecological Section, in point of fact being a part of and tying up with the latter feature. The desirability of making the rock garden an adjunct to the Ecological Section resulted in a general easterly exposure which is not considered ideal from the gardening standpoint, because of the lack of shade for the plants that object to full sunshine. This disadvantage has been overcome by saving a few small trees that happened to be on the site and by disposing many of the larger boulders so that they cast some shade.

Rock gardens undoubtedly were brought into existence mainly for the benefit of alpines; rock plants, not necessarily alpines, being included later. In actual practice most rock gardens are not limited to these two groups. At the present time, in many well known gardens, almost any hardy plants of a dwarf nature are considered a suitable planting material. The late Reginald Farrar, the well known English authority on rock gardens, in his definition of plants suitable for a rock garden . . . "includes everything that will look well in a rock garden." Under this ruling many plants, not alpine, not saxatile, and whose cultivation presents no difficulties under the conditions obtaining in the perennial border or shrubbery must be admitted. Owing to the difficulty of quickly assembling a large collection of alpine and rock plants, and the necessity of planting some quick-growing material to hide the glaring hideousness of some of the boulders, Mr. Farrar's definition of what constitutes a rock garden plant has been temporarily accepted by the Botanic Garden. The ideal in mind, however, is to strictly limit the planting to material that really "belongs." With this end in view, our stock of alpine and rock plants is constantly being increased by propagation from seeds and cuttings, and by exchange and purchase. Since the rock garden has been in existence, many species extremely rare in cultivation in this country have been raised and bloomed either in the rock garden or in the cold frames. Included amongst these rarities have been such difficult species as *Anemone vernalis*, *Campanula Allionii*, *Saxifraga Grisebachii*, *Diapensia lapponica*, *Rhododendron lapponicum*, and *Phyllodoce caerulea*. Unfortunately, the actual planting cannot go on as fast as could be desired. Many of our rare plants have been stolen almost immediately after being set out (apparently we have a connoisseur of alpine plants in our midst), and in some cases our entire stock of some plants has been lost in this way. This has indicated the necessity of waiting until a considerable quantity of these rare plants can be propagated before planting any of them in the garden, so that a reserve supply may be held in a more secluded spot to guard against accidents and vandalism.

MONTAGUE FREE.

GARDEN NOTES

The perennial water lilies in the southern pool commenced flowering about June 1, and while the blossoms are still few—yellow, pink, rose color, and "blood orange"—by the end of the month they should make an attractive showing. The time for setting out the tropical varieties in the northern pool has been considerably delayed on account of the unseasonable cold weather in May.

As this leaflet appears, the peonies are coming into flower in the conservatory plaza, along the borders of the lily pools. Set out here in October, 1920, each year the plants increase in size and productiveness, altogether about 25 varieties being represented.

Just north of the entrance to the conservatories is "*Adolphe Rousseau*," one of the darkest flowered of all peonies, with a shade much like that of garnet—the bright yellow stamens in the center of the semi-double flowers contrasting well with their dark background. South of the conservatory entrance, on the east side, at the center, is a striking form known as *Whittleyi major*, a single-flowered peony, white petalled, but with a suggestion of rose color, and, at its center, a dense circular cluster, two inches or more in diameter, of yellow stamens. From a little distance these flowers resemble some giant species of Anemone, a genus which is also included in the Buttercup Family (*Ranunculaceae*) to which the peony belongs. But as a matter of fact, the "Anemone" type of peony flower, a term used by horticulturists, is somewhat different—a form in which the filaments have lost their anthers and are broadened out, petal-like, though still short.

On the west side, along the northern pool and near the center, is *Boule de Neige*, a large double white-flowered variety with a plentiful supply of petals, a small group of bright yellow stamens, and, at the very center, bright crimson stigmas. *Boule de Neige* is not quite the full double or "Rose" type, coming rather under the class of "Semi-rose," since some of the stamens have not been transformed into petals, although the "guard" or original petals are indistinguishable from the petal-like parts resulting from the transformation of stamens. A survey of the different varieties blooming in the four plots about the lily pools reveals most of the stages in the development of double flowers from single up to "rose"—in the latter case every stamen and carpel having been transformed into petals.

A very valuable and interesting book explaining simply and clearly these different types of peony flowers as well as setting forth the history of peony cultivation from early times, together with practical details of importance to those interested in peony culture, is Mrs. Edward Harding's "The Book of the Peony," published in 1917, a copy of which is in the Garden Library. Four bulletins published by Cornell University, also on file in the Garden Library, are indispensable to peony lovers. These are:

Coit, J. E. A peony checklist. Prepared with the cooperation of the committee on nomenclature of the American Peony Society. Cornell Univ. Dept. of Hort. 1907.

Coit, J. E. The Peony. Cornell Univ. Agr. Exp. Station Bulletin 259. 1908.

Batchelor, Leon D. Classification of the peony. 3rd Report. Cornell Univ. Agr. Station Bulletin 278. 1910.

Batchelor, Leon D. Classification of the peony. 4th Report. Cornell Univ. Agr. Station Bulletin 306. 1911.

ARTHUR HARMOUNT GRAVES.

BROOKLYN BOTANIC GARDEN

LEAFLETS

SERIES XI BROOKLYN, N.Y., SEPTEMBER 19, 1923. NO. 7

SOME SEPTEMBER FLOWERS AT THE GARDEN

West of the stream and a little north of the Ecological and Rock Gardens, a new area, hitherto unoccupied, has been opened up for the reception of the Monocotyledons.

The Monocotyledons and Dicotyledons are two chief groups of flowering plants which, in most cases, are easily recognizable by the appearance of the leaves. Most of the Monocotyledons, among other characteristics, have parallel-veined leaves (although there are exceptions to this), and we may regard the Grass, Arum, Lily, Banana and Orchid families as typical representations of the group.

Recent studies in the evolution of plants have led many botanists to believe that the Monocotyledons have descended from the Dicotyledons (although the reverse was formerly the accepted view)—not in a direct line, but as an offshoot from some of the earlier members of this group (comprising the order Ranales) such as the Magnolias, Buttercups, Water-Lilies, etc., for some of the Monocotyledons have characters in common with these Dicotyledons. Hence their position here in the Garden, across the brook from the Ranales, is particularly appropriate, for the underlying aim throughout the arrangement of the systematic section is to present the different plant orders in such a way as to indicate as nearly as possible their natural relationship and their relative position in the course of evolution.

The Cannas.—Among these Monocotyledons the Cannas are at present producing a handsome display of flowers, and are well worth a visit. They will continue blossoming until frost, and judging by the present profusion of buds should prove even more striking later on in the month and in October.

The collection is a gift to the Garden this year from the Conard and Jones Company, nurserymen and rose-growers of Westgrove, Penna. During the past twenty-five years this firm, through the work of its vice-president, Mr. Wintzer, has originated and introduced nearly 100 new varieties of Canna. Forty kinds are growing in the Garden, comprising over 500 plants. It is seldom that one has an opportunity to see a named collection of Cannas, but here each variety is labeled. The brilliant carmine and scarlet shades of American Beauty, President, Fiery Cross, and Conowingo are particularly effective, while the beautiful rose tints of California, Mrs. Conard, Susquehanna and others are unusual in a Canna. Apricot is another remarkable variety with a color true to name. Niagara—vermilion edged with bright yellow—is a conspicuous form; while planted just back of this is Gladiator—yellow spotted with red and descriptively named. King Midas—an exquisite golden yellow—is appropriately named. These are a few of the more conspicuous forms. Compared with the Cannas of a generation ago, grown merely as foliage plants, with small and insignificant flowers, the chief merits of the plants being their size and the handsome large leaves—compared with these old-fashioned Cannas, the whole collection, with its brilliancy and latitude of color and size of flowers is certainly a triumph of the plant breeder's art.

The structure of the Canna flower is peculiar, and not easily understood unless one is let into the secret; then it is simple. The showy part of the flower is not furnished by the petals at all, but by staminodia or sterile stamens, which through hybridization and selection have been developed to their present remarkable size and coloring. Three of them (rarely four) are much elongated and broadened, while one is deflexed and narrower and forms the lip of the flower. A fifth, also narrow and usually somewhat coiled, is only half sterile, for on one side of it a single-loculed anther is borne—the only pollen-bearing part to which the flower can lay claim. In the centre is a single, colored, sword-shaped style. When we identify these parts, the mystery fades away, and law and order prevail once more. For the three narrow, inconspicuous, long-pointed petals, only faintly colored, their edges inrolled, can be easily distinguished just outside the staminodia; and at the very base of the flower, alternating with the petals, just as they should in a good, orthodox monocotyledon are the three small, green sepals. Notwithstanding the small supply of pollen produced, good seeds are formed, as attested by the numerous, plump, green ovaries on many of the old inflorescences.

It is interesting to notice the young, unfolding leaves in the center of the plant, which at first are rolled up like a long cigar. On this account the natives of the Spanish West Indian countries call the Canna the Cigarullo or Cigarro plant. Cannas are found wild in these countries and in tropical and subtropical Asia.

Plants true to name are easily propagated by dividing the rootstock, which branches vigorously and produces buds, each of which will produce a new plant. The rootstocks may be kept over winter in a cellar or similar location where potatoes will keep well. The culture is easy, demanding a warm, rich soil, but the plants must be given water in dry weather. The flowers should be picked as soon as they wilt to prevent the formation of seed; otherwise the flowering is lessened.

Heath and Heather.—Near to the terminal pool of the brook and opposite the children's gardens, may be seen at any time now various species of Heath and Heather in bloom. Varieties of Heather (*Calluna vulgaris*) with their dense spikes of white, pink or lavender flowers, are planted in the bed to the northwest of the pool. Those who have never seen the hillsides covered with this plant in bloom among the Highlands of Scotland can imagine from this small sample what a glorious sight it is. But Heather is by no means restricted to this region; it is common on the moors of the British Isles; and widely distributed in the uplands of Europe, even to the eastern slope of the Ural Mountains.

At the southeast end of this same bed may be seen two species of Heath in bloom, the one nearest the pool being the Corsican heath, *Erica stricta*. The Heath (*Erica*) is an entirely different genus from the Heather (*Calluna*), although in common usage the two names are used rather loosely. Heaths, of which there are many different species, may be distinguished when not in flower by their needle-like, usually spreading leaves, while the leaves of the Heather or Ling, of which there is only one species, with several varieties, are minute and scale-like. The flowers, too, as one may observe in these Garden plants, are quite different: those of the Heath have a bell-shaped flower with a short calyx, while in the Heather the calyx is larger than the corolla, colored like it, and after the blossoming period is past, folding its tips inward, and still retaining its bright color for many weeks. Other species of Heath, of which the Cornish Heath (*Erica vagans*) is now in flower, extend along the northern border of the Azalea knoll toward the west. At this spot one must not forget to notice the Sea Lavender (*Limonium*) in bloom nearby, with its exquisite blue flowers.

To the eastward of the Heather and close to the northern bank of the terminal pool is a large plot of the Swiss Heath (*Erica carnea*). All summer it has been forming its clusters of flower buds—merely its policy of preparedness, however, for the pretty, rose colored bells are not due to open until next March or April. Unfortunately, last winter many plants of this species were killed.

Four O'Clocks.—In the northern part of the systematic section, not far from the Gingko triangle, and a few feet to the westward of the fasciated heads of red or yellow Cockscomb (*Celosia cristata*), is a plot of ground given over to the Four O'Clock family (*Nyctaginaceae*).

A large part of this is occupied by plants of the Four O'Clock itself (*Mirabilis Jalapa*), plants now covered with a profusion of brilliant flowers—some a deep carmine, others a citron yellow, still others a rose pink, and finally a pure white variety. These remarkable flowers, somewhat resembling a petunia in general appearance, are closed during the brightest parts of the day, but commence to open at four o'clock standard time, or five o'clock, daylight-saving time. Like many of our conservative citizens, they refuse to recognize the daylight-saving regime. They remain open during the night and close at about eight o'clock (standard) the following morning. Each flower opens only once. On dark days, however, one is apt to find them open during the day.

The Four O'Clock is a native of tropical America, from which it was taken to Europe for cultivation more than 300 years ago. It is commonly treated like an annual and raised from seed, but, like the white potato, it is strictly perennial in its native home. Formerly it was in high esteem, for it is one of the "old-fashioned flowers." It deserves a revival of popularity among gardeners and flower lovers as well for the beauty of its flowers as for the interesting clock-like regularity of their opening and closing. Even as far north as New York it produces tuberous roots large enough to be taken out of the ground and stored like dahlias. Plants raised from such roots are stronger and will yield better and more abundant flowers than those raised from seed.

In the same bed with *Mirabilis Jalapa* is another species, *M. longiflora*, with very long, tube-like flowers, flaring at the end like a trumpet. This too is an evening bloomer. It has a delicious perfume, but is not as showy as the other species. The well known Bougainvilleas, commonly offered for sale in florist's shops, are members of the same family and form a conspicuous part of American tropical vegetation. One may see plants of these, which flower in early spring, growing in Conservatory House, No. 3.

Perennial Asters.—These are now in their prime. It will be recalled that the stock was brought back in the summer of 1921 by Mr. Free, Horticulturist at the Garden, from Aldenham House Gardens, near London. As noted in the LEAFLETS last year, they made a splendid display and grew so vigorously that this year they have been divided, representatives of the best varieties having been planted among the Compositae in the Systematic Section, southeast of the Rock Garden. It is interesting to note that stock thus transplanted and restricted to three or four shoots for each plant thrives much better than the original stock. The contrast in height, vigor, and profusion of flowers is astonishing when one compares the parents and the offspring at the Garden. It is true that in this case the parents may have been somewhat dwarfed by the shade of the honeysuckle nearby, which has also perhaps in some degree robbed their soil of its nourishment; but these conditions can at best account for only a small part of the difference.

We must bear in mind that these Asters are, for the most part, American species improved by English horticulturists, and furthermore, that they are true Asters, belonging to the genus *Aster*, and called in England "Michaelmas Daisies." The larger, chrysanthemum-like Aster of our gardens, commonly called the China Aster, belongs to another genus, *Callistephus hortensis*, and is a native of China.

ARTHUR HARMOUNT GRAVES.

BROOKLYN BOTANIC GARDEN

LEAFLETS

SERIES XI BROOKLYN, N.Y., OCTOBER 3, 1923. NO. 8

EL MONTE

> "Do you know the steaming stillness of the orchid-scented glade
> When the blazoned, bird-winged butterflies flap through?"

Several hundred miles to the west and over 15,000 below us lay the ocean—the calm, blue Pacific—washing a rocky, treeless desert shore—the home of guano and its makers—millions of screaming sea birds, literally blocks upon blocks, acre upon acre of them, much of the time packed as closely as our own downtown subway stations during the rush hours. Not alone were these shores and adjacent waters crowded with them, but teeming millions filled the air like screaming crowds of vocal leaves. And the whole coast was permeated by the concentrated essence of the guano—the odors of dozens of Barren Islands, while one of the towns perched on this dusty, smelly coast is often referred to as "the urinal of the Pacific."

Between us and the ocean lay a high desolate plateau, the most populous part of Bolivia and the western Cordillera, over which we had climbed up 13,000 feet or more by rail on the weekly passenger train. This plateau rivals Asiatic Thibet in scenic grandeur of barren, desolate, stony, treeless expanses (I want to call them moors); of remnants, relics, and ruins of picturesque, mysterious, ancient civilizations; of mountain peaks — snow-capped and quiescent, or bare, and occasionally active, belching smoke. The air is thin, the cold intense, even under heavy covering at night. And this is only a few hours away from irrigated valleys where oranges and bananas flourish. Rosy flamingos dot plateau marshes, and the llama, the camel of the western world, is an everpresent object in the landscape, in colors and patterns as diverse as Jacob's cattle.

We are standing on the highest point of Quimza Cruz (over 15,000 feet altitude), the pass of the three crosses—a pass of the eastern Cordillera or main Andean range—the ridgepole of the roof of the Western World. Like the Khyber Pass of the Old World, this pass, too, is a very ancient travel route over which the Aymara Indian from prehistoric times has driven his produce-laden llamas from the narrow, cloud-embowered, semi-tropical valleys of the Yungas to the plateau cities of Bolivia; for the plateau from time immemorial has been the center of prehistoric civilizations. A huge pile of stones contributed to by each passing caravan gives some idea of the age of this travel route.

On the other side, five to six thousand feet below us to the east and northeast begins the great forest, which lies for thousands of miles an almost unbroken wilderness of luxuriant vegetation, the richest, when we consider its extent, that the world knows. Here and there are tiny clearings or oases up to a few dozen square miles in area that indicate the attempts of man, as yet but feeble, to plant his civilization and make a stand against "El Monte."

For "El Monte" is *the great forest*, the forest grand, and carries an almost God-like significance. Mere woods are "el bosque," but *El Monte* refers colloquially to that marvellously diversified mantle of forest green that for the most part densely covers the whole of the Amazon River valley, rising like walls from the river courses and dotting itself like islands over the fringe of park-like country where it meets the treeless pampas or prairies. These forests neither contain the largest trees in the world, for this is California's glory, nor are the trees as tall as the eucalypts of Australia; but for numbers of huge individuals and for diversity of kind, no other forest is the equal of *El Monte*, not even those of the East Indies and southeastern Asia. A million men doubtless might easily and permanently lose themselves in this vast area and not meet each other.

Such a region contrasted with our temperate forests has many marked general differences. Our forests are catalogued generally as coniferous or hardwood or a mixture. *El Monte* is for the most part hardwood—there being no conifers or cone-bearing evergreens, even in the mountains. There a few soft wooded types such as the balsa (*Ochroma* sp.) and related species. The hardwoods range from moderately hard to very hard wood types, such as the locally named "iron wood," lignum vitae, and many specimens belonging to the pea family. The temperate forests very often have considerable areas covered with comparatively few kinds of trees and we refer to them as oak forests, beech forests, plum bush, sugar maple bush, hemlock forests, and so on. Rarely, if ever, is this true of the Amazon forests. Here and there you find individual trees of a kind, but never in such numbers and purity that you can refer to them as a rubber forest, a brazil nut grove, a wild chocolate or cacao bush. Along the rivers there are a few plants that exist in crowds of their own kind—such as the bamboos, the giant canes (*cana brava*) or *Gynerium* and some of the small trees and brush belonging to the sunflower family, but for the most part plants exist as individuals rather than as masses.

A metropolitan newspaper man who once asked me how many of our kinds of plants grew there, was much astonished to find that most of them were absent and those that were there were not at all striking. No oaks, no chestnuts, no Christmas trees (conifers), no maples, beeches, cottonwoods, elms, apples, horse-chestnuts, sycamores, nor birches. There were willows, alders, and walnuts in the Andean foothills, but these were never striking nor numerically common. Of the great tree-containing families with which we are familiar, other than those mentioned above, only the rose, catalpa and pea families are prominent. The catalpa or trumpet-vine family is one of the chief glories of the Amazonian forest from the standpoint of flowers, for in the monotonous everlasting greenery these form color spots that really come up to one's expectation of what the tropics should do, and they bloom in such a profusion of color,—pink, red, purples, oranges, yellows, creams and whites. Most of the Amazonian tree families would be strangers to us, even to most botanists; but some of the magnificent trees of this region belong to families with which we are familiar for their garden plants and herbs. For example, a magnificent tree with long racemes of showy, blue flowers, is a cousin of our verbena; and there are many trees 30-40 feet high that belong to the potato family, for this part of the world, judging from the number and diversity of kinds, was the original starting place of this group. But it does strike one oddly to come up to a tree 30-40 feet high, and find it covered with large, purple flower-clusters for all the world, when looked upon casually, like potato flowers. One might almost expect to find a tree 100 feet or so high full of sunflowers after this experience unless he were a botanist well versed in geographic botany. The Euphorbia family is another group with tree-like forms—many of which are economic. To these belong the Para rubber tree (*Hevea*) from which most of the world's rubber now comes, the castor bean, and the cassava or tapioca plant—the first and third being native to this region while the castor bean is a sort of tropical tramp. The rubber tree makes you think of the castor bean—especially when you are acquainted with the fruit and seeds of both. Each have the queer beetle-like seeds, with mottled patterns, and both have fruits which explode when ripe. Our northern pawpaw is well fixed with cousins through this region, as there are numerous types of sweetsops, soursops, custard apples and cherimoyas. And to the latter fruit—I cast my vote for the queenship. Imagine a fruit somewhat heart-shaped the size of a large orange, its exterior surface reminding one of an artichoke, except that the color is more yellowish than green, and one cheek has a rosy, bronze blush. The skin breaks easily and the interior is full of a creamy pulp reminding me very much of the most excellent home-made vanilla ice-cream. The seeds are black but not troublesome. Cooled, after a hot walk, I asked for nothing more delicious. Cherimoya is sometimes used as a nickname for a pretty girl, so highly is it esteemed.

Many people seem to think that in the tropics the leaves never fall—but here again the casual observer would rarely notice the difference, because of the wealth of greenery to take their place. The fact is they are always falling. Falling fruits and falling leaves were common night sounds. Each type of plant has its resting period and many of the trees become entirely leafless. Fall colors as a rule are rare, but some trees like those of the genus *Croton* (not the croton (*Codiaeum*) of the greenhouse) have leaves that change to a brilliant salmon orange before they are shed, while those with leaves changing to a yellow are not at all uncommon. But the relatively few plants that at any one time change their dress make no striking impression on the everlasting wall of green. Then too, these resting trees or shrubs may themselves be covered with green from parasitic, epiphytic or vine growths. I have seen many trees so full of parasitic bushes of the mistletoe family that one could easily believe the host tree to be fully foliaged or in full bloom. At times a whole leafless forest covered with epiphytic (non-parasitic) bromeliads, members of the pineapple family, will appear to be one mass of cerise and blue spikes of flowers from tufted twigs, but these will be merely the bromeliads taking advantage of the sunlight to get their seeds developed and out of the way before the trees on which they are perched once more resume their foliage.

Many of these Amazonian plants are in the greenhouses of the Brooklyn Botanic Garden, where those interested in tropical vegetation can gain a much better idea of such plants:than from leisure reading. Among them may be mentioned the alligator-pear tree, the butter-color tree (arnatto), the vanilla vine, the cigar box (Spanish cedar) tree, mahogany, pineapples, papaya (the tropical pawpaw), balsa trees, monsteras, water hyacinth. For literature of a semi-popular nature, yet authentic, read Spruce's "Notes of a Botanist on the Amazon and Andes"; Bates' "Naturalist on the Amazon"; Tomlinson's "The Sea and the Jungle." They are all very readable. For descriptions of tropical fruits, there is Popenoe's "Manual of Tropical and Subtropical Fruits."

ORLAND E. WHITE.

FALL LECTURES

Fridays at 4: Oct. 5—Nov. 2 (omitting Oct. 12)

1. *October 5.* The Life of the Plant. ARTHUR HARMOUNT GRAVES, Curator of Public Instruction, Brooklyn Botanic Garden.

2. *October 19.* Bulbs and Their Allies. HUGH FINDLAY, Assistant Professor of Agriculture, Columbia University.

3. *October 26.* The Evolution of Flowers. ALFRED GUNDERSEN, Associate Curator of Plants, Brooklyn Botanic Garden.

4. *November 2.* Ten Years of Garden Work with Brooklyn Boys and Girls. ELLEN EDDY SHAW, Curator of Elementary Instruction, Brooklyn Botanic Garden.

5. *November 9.* The Story of Wheat. GEORGE M. REED, Curator of Plant Pathology, Brooklyn Botanic Garden.

BROOKLYN BOTANIC GARDEN

LEAFLETS

SERIES XI BROOKLYN, N.Y., OCTOBER 17, 1923. NO. 9

EVOLUTION IN FLOWERING PLANTS

"Phanerogams are higher than cryptogams, and angiosperms are higher than gymnosperms; yet there is no culmination in the vegetable kingdom, nor any highest or lowest order of phanerogams." Thus wrote Asa Gray about forty years ago.

At present it would seem preferable to say that there are a number of divergent lines of evolution among angiosperms. Cacti, mints, composites, grasses and orchids are examples of terminal forms. On the other hand, near the base of the angiosperms were forms probably not unlike birch or magnolia.

On what bases are some forms considered more primitive than others?

Since the general acceptance of the principle of evolution (descent with modification), classifications of plants and animals have aimed to exhibit the course of their descent. In some groups the various lines of evidence support one another. When the study of fossils, and of comparisons of different forms, and of the development of individual forms, all point in one direction, the resulting classification becomes, so to speak, iron-clad. In other groups "missing links" render conclusions uncertain, resulting in divergent classifications. But even where relationships are entirely obscure it is necessary in some way to classify the various groups. In any case a natural classification of any group is more or less of the form of a tree.

The present LEAFLET aims to state in the briefest way more or less generally accepted views of evolution, as applied to the parts of angiosperms or flowering plants: the seed, stem, leaf, and especially the flower.

Seed. Evolution in angiosperms is believed to have proceeded from seeds with two seed-coats to those with only one. Most of the plants whose flowers have separate petals (*Polypetalae*), and also the orders of primroses and gourds, have two seed-coats. Most of the plants whose flowers have united petals (*Sympetalae*) and also the order of dogwood and carrot (*Umbellales*) have only one.

Evolution doubtless proceeded from seeds with endosperm (a store of food outside the embryo), as occurs in magnolia, pink, dogwood, and grasses, to seeds without endosperm, such as in the pea, gourd, sunflower and others.

Embryos with two or more "seed-leaves" or cotyledons appear to be more primitive than those with one. The conifers have usually many cotyledons, the joint firs (*Gnetales*) two. The great group of the monocotyledons, with one cotyledon, represents almost certainly one or more branches from the early dicotyledonous plants.

A straight embryo, such as is found in most flowering plants, must be considered as simpler than a curved one, such as characterizes the pink, pigweed, four-o'clock and other families.

Stem. The idea that trees and shrubs are on the whole more ancient than herbaceous plants, is one of the most significant recent developments affecting the classification of flowering plants. The gymnosperms, that is, the lowest seed plants, of which fossils far antedate the flowering plants, have no herbaceous forms. In the *Sympetalae*, that is, the highest seed plants, the proportion of herbaceous species is very much greater than in the lower group, the *Polypetalae*. In groups including woody and herbaceous forms such as the pea family, the herbaceous ones have the most advanced floral structures. The time of one generation, from seed to seed, is much longer for trees and shrubs, so that in a given long period we might expect a more rapid evolution among herbaceous forms. In other words, woody plants are the conservative, ancient forms. Herbaceous plants appear to be essentially an adaptation to climates with a winter season. It has been said that the phylogenetic tree of seed plants is like a living tree, in that the tips of the branches are herbaceous, the lower parts woody. The parts of the tree of evolution below the seed plants, it might be added, are again doubtless herbaceous, and the very lowest are water forms, somewhat as follows:

Herbaceous angiosperms
|
Woody angiosperms
|
Gymnosperms
|
Ferns
|
Liverworts
|
Algae

The herbaceous angiosperms are not a single group; they must have arisen from numerous woody sources.

The vessels or water-carrying tubes of flowering plants have walls provided with numerous thin areas or "pits." These are in most cases small and round, or in part linear. Exclusively linear pits, the so-called scalariform or ladder-like form, occur in comparatively few families, notably the magnolia, witchhazel, saxifrage, dogwood, honeysuckle, holly, heath, and tea families. These linear pits characterize most of the earliest fossil angiosperms and must be considered as the primitive type.

Leaf. Just one genus of gymnosperms, *Gnetum*, possesses the typical, simple leaf of the dicotyledons. Divided and compound leaves must be considered as derived forms. There are reasons for considering palmate venation as more primitive than pinnate venation.

Flowers. Single flowers, as in buttercups, and loose inflorescences, as in mustard, are considered primitive; dense inflorescences, especially umbels (Queen Anne's lace), and heads (daisy, sunflower) are considered advanced forms.

A great majority of the angiosperms have the floral parts arranged in whorls. In several of the families of the magnolia group (although in the genus *Magnolia* the floral envelopes are cyclic), in the cacti and in a few other families the parts are more or less spirally arranged, doubtless the more primitive form.

Following the appearance of the whorled arrangement of flower parts, there begin to appear more or less cohesion of the parts and also adhesion of the adjacent whorls.

Perianth. A distinct calyx and corolla is usual among flowering plants. The absence, as in magnolia and lily, of a marked distinction, must be considered more primitive.

So-called united petals have not really united. What happens is that there is a "zonal" development from the receptacle or base of the flower, resulting in a continuous, more or less tubular corolla or calyx, as in the morning glory or bellflower. The first parts of the sympetalous corolla to appear, however, are the separate tips. In other words, the sympetalous flower in the course of its formation begins as polypetalous—apparently a recapitulation of the evolutionary history. In dandelion and other composites the five petals are represented by the five teeth at the edge of the strap-shaped corolla.

United sepals occur much oftener than united petals. In fact separate sepals are the exception. They are found generally in three orders: *Ranales* (buttercup), *Parietales* (rockrose, violet), and *Papaverales* (poppy).

The early flowers were doubtless regular, that is, having all the parts in a whorl similar, while irregular or zygomorphic forms, such as foxglove, are an adaptation to insect visitors, facilitating cross-pollination: these must be derived forms.

The color and fragrance of flowers are also considered as adaptations to insect visitors. The green and yellow colors apparently preceded the red, purple and blue.

Stamens. In the *Polypetalae* there are generally two whorls of stamens, though the *Umbellales* (dogwood) have only one. The *Sympetalae* have only one whorl, except the *Ericales* (heath) and *Ebenales* (persimmon). In the *Primulales* (primrose) there is often only one whorl evident, but then the stamens are situated opposite the lobes of the corolla, and traces of an alternate whorl can often be found.

In the *Polypetalae* and in the *Ericales* the stamens usually arise from the receptacle. In the *Sympetalae* the stamens usually are epipetalous, that is, growing out from the corolla tube, obviously the derived form.

The stamens are also sometimes united; either the filaments form a tube, as in the mallow family, or the anthers unite, as in lobelia and composite families. It is of interest that united stamens occur also in the strange gymnosperm *Welwitschia*, a native of South Africa. In the orchids the stamens and pistil grew together on a common structure, a specialized arrangement.

Carpels. The carpels are the units of structure of the pistil. In the gymnosperms the seed-bearing scales are separate. Separate carpels, in the angiosperms, occur chiefly in the magnolia group and in the rose family, an important evidence that these families are primitive. Sometimes the bases of the carpels cohere slightly, as in geranium, with the styles separate; more often the styles and stigmas are also united, as in primrose. The compound pistil is obviously the more advanced form.

Numerous ovules to a flower are more common in the lower families. Fewer cells per ovary and fewer ovules per cell appear in higher groups. A single ovule to a flower characterizes the most specialized groups, such as the composites. A reduction in the number of ovules in plants may be compared with the reduction of the number of eggs in animals. Among the fishes enormous numbers of eggs are laid, but only a few develop. Among the mammals, on the other hand, comparatively few young are born, but these are taken better care of. So that among plants, as among animals, increasing care of the next generation appears to be an all-important principle.

A single seed to a flower is also common among wind pollinated plants. This may perhaps be due to the difficulty of pollination by the wind. That is, several ovules would have small chance of pollination, as compared with the chance in insect pollinated plants.

The occurrence of birches and their relatives among the earliest angiosperm fossils, their wood structure in many ways suggesting the *Gnetales*, their wind pollination and their cones much like conifers, assign to them a place among the primitive angiosperms.

The mode of attachment of the ovules is called *placentation*, the region of attachment of the ovule being called a *placenta*. The ovules are usually borne on the margin of the carpellary leaves. With the carpels closed to form a compound pistil, the ordinary *axile* placentation results. *Parietal* placentation, as in rockrose, violet and poppy, and *central* placentation as in pink and primrose, are probably derived forms.

Where the three outer whorls of the floral envelope develop more or less together, an *inferior* ovary results. This advanced form characterizes the great orders *Umbellales* (dogwood), *Myrtales* (myrtle), *Rubiales* (honeysuckle), and *Campanulales* (bellflower and composites) and a few other groups.

Considering the flowering plants as a whole, two great tendencies appear to have been effective; a tendency to an increasing fusion of the parts, and a tendency to increasing adaptation to insect pollination.

How are the above considerations to be applied to the classification of the flowering plants? This must form the subject of a later LEAFLET.

ALFRED GUNDERSEN.

THIS NUMBER COMPLETES SERIES XI, 1923.

BROOKLYN BOTANIC GARDEN

LEAFLETS

SERIES XI | BROOKLYN, N. Y., OCTOBER 31, 1923. | NO 10

TEN YEARS OF WORK IN ELEMENTARY EDUCATION AT THE BROOKLYN BOTANIC GARDEN

The Brooklyn Botanic Garden completed ten years of work with elementary school boys and girls on October 1, 1923. During the first year of its connection with the schools of the borough, the Garden started certain pieces of work which have been continued year by year.

In making a survey of these ten years of work, it might be profitable to take up the different activities and, in a few words, rehearse their objects and their growth. The Department of Elementary Instruction was planned, by the Director of the Garden, to be a natural link between the Brooklyn Botanic Garden and the teachers and pupils of the elementary schools of Brooklyn. With this viewpoint in mind, the work, from its inception, has dropped into the following general lines: extension work for teachers; regular classwork at the Garden for boys and girls out of school hours; visiting classes from elementary schools in school time; an outdoor experimental garden for children; a garden exhibit held annually to round up the garden work of the boys and girls of the entire borough; the supply of packets of seed to the children in the schools of Brooklyn; and lecture and conference work.

Extension Work for Teachers.—A course of study planned to prepare teachers of school gardening is given annually. This course of instruction is made up of five courses thirty weeks in length. It was believed in 1913 that students would come to the Brooklyn Botanic Garden and complete the course within the year. That this is done, is more or less true today; but the demand for the course given piecemeal or subject by subject, thus extending the period of completion over several years, has been so great that at the present time the courses are under our local teachers' organization, the Brooklyn Teachers' Association, to meet this demand. College credit is given for the courses, which are purposely planned to cover thirty weeks, thus counting as two college credits. From a request made by one student for these courses in December of 1913, we have now a registration of 122 students. During the first four summers of the work of this Department a summer school for teachers in children's garden work was organized. On account of the growth of other lines of work, without a corresponding increase in personnel, it has not been possible to continue the summer course, although students come during the summer for outdoor garden practice.

Regular Classwork for Boys and Girls Out of School Time.—Regular classwork for children in plant-nature-study and gardening seemed a natural outgrowth from our pedagogical work with teachers in the above mentioned courses. A little school of education is to be found here. Boys and girls come regularly every Saturday morning during the year, with the exception of the Saturdays in January, to carry on work in plant-nature-study and gardening. Here principles of education and new phases of work in nature study are demonstrated. The boys and girls range in age from six to eighteen years. They are taught in groups numbering from 15 to 24 students: occasionally a class will run to 30 members, but the larger number is not encouraged. The advantage of such a demonstration school is self-evident. The boys and girls in these classes pay a nominal fee for their classwork. The main purpose of this fee is its educational effect on the children, the underlying principle being that one tends to value what he pays for more than what he receives for nothing. It might be well to add here that the work done by these boys and girls in their regular classes is so planned that course after course builds a definite body of knowledge about the world we live in, and is not composed of a series of wholly unrelated subjects. The attendance in these classes during the first three months (October, November, December, 1913), was 544. The attendance for the nine months from January 1 to October 1, 1923, was 17,380.

Out of this group of regular students was inaugurated a Boys' and Girls' Club. This was started in 1916 and numbers many thousands of members.

Visiting Classes.—On October 6, 1913, the first visiting class came to us. It was made up of 17 girls. On October 6, 1923, the total attendance of visiting classes for this year had reached 41,166. Our visiting classes come for work which is based on the City Syllabus of Nature Study and Geography, a course of study arranged for the schools in Greater New York. Twice a year lists of talks in the form of posters are sent to the schools of Brooklyn. Teachers or principals sign up cards, sent with the poster, for the lectures desired by their schools at a time suited to their own programs. The work with visiting classes offers great opportunity in visual education. Motion pictures are used, but only under a restricted educational plan which we are developing. It has seemed to this institution that motion picture reels should not be a matter of mere entertainment, but a part of a well-regulated, definite plan for visual education. A series of syllabi has been printed on subjects given at the Garden.

These syllabi are most valuable when large groups are involved. Each teacher is given a sufficient number of syllabi to supply all the members of her class. The syllabus, to us, represents a very definite help in education. The attendance in all the classes, both regular and visiting (this includes teachers' classes), shows a healthy and normal increase from 1,364 in 1913 to 130,667 to date (October 23) in 1925.

Outdoor Experimental Garden.—Our first outdoor garden—a demonstration garden planned for education alone—was started in the summer of 1914. It comprised three sections of land, one upon which our children's greenhouses now stand, the second at the side of the building along Washington Avenue, and the third, upon the land where the main or new part of the Laboratory Building now stands. The first section of the garden was used as a practice garden for junior or senior students of Pratt Kindergarten Department. It is an interesting fact to know that the children in this part of the garden were old students of the little Kindergarten Practice School connected with the Pratt Kindergarten Theory Department. These children entered the garden at the request of Miss Alice E. Fitts, Director of that School. who felt that the outdoor garden was of inestimable educational value in the training of children. In 1917, the children's garden was moved to its permanent quarters, the lower end of the Botanic Garden grounds. During the war years, available space in front of the Laboratory Building and a part of the area now used for experimental work in plant breeding and plant pathology, were used for children's work, but later the work for children became concentrated on the present piece of land allotted to children's garden work, in the southern part of the Garden.

The available space for raising vegetables is between one-half and three-quarters of an acre, and from this area we took $2318.61 worth of crop this season. From a garden ten by twelve feet, about $19.35 worth of crop was taken, while $13 90 worth of crop was taken by the owner of an eight by ten garden. The figures in themselves mean very little ; the fact remains that good gardening principles, well taught, ought to produce good results. Our outdoor garden represents many public, private and parochial schools and is not a neighborhood garden. Our plan is to disseminate knowledge and not to concentrate it in any one small section of our Borough.

Annual Garden Exhibit.—Every fall an exhibit is held for the boys and girls of the borough who may display the flowers and vegetables they have raised in either home or school gardens. The boys and girls of our own outdoor garden do not enter the exhibit. During the war the Garden offered prizes in the form of war stamps for the best home gardens from which the greatest crops were taken from given areas. After the war closed this phase of our work was dropped. Also in our early years we visited home and school gardens all over the borough. Now conferences are held at the Garden to help teachers in plans for their gardens. Our last Garden Exhibit included the work of about 15,278 children and 417 teachers.

Penny Packets of Seed.—Packets of seeds have been sold to children in the public schools ever since 1914. It seemed a natural way to help home gardening and thus come in touch with the garden work of the boys and girls all over the borough. Twenty-five thousand penny packets were sold in 1914. These were all stamped and put up by hand. Since then the price has been changed from one cent a packet to two, because of the increased seed price, which has not changed materially since the war. Now our envelopes are printed, and there is a regular seed-packing room set aside for this purpose alone. In 1923, 170,413 packets of seed were distributed.

Lecture and Conference Work.—This Department has contributed its part in lecture work -representatives speaking at Mothers' Clubs, Women's Clubs, schools, and churches. So far in 1923 over forty extra-mural lectures have been given. Besides the lecture work, a certain amount of written work is put out each year for publication in educational journals and magazines. A great deal of time is taken in the Department of Elementary Instruction for conferences with heads of schools, and with teachers. During 1923 the conferences held so far have affected and influenced 121,451 individuals. Through its regular and visiting classes, the Department has distributed 7,422 plants, including over 3600 potted plants for the beautifying of school rooms.

While figures do not tell the whole story, they do help one to understand the progress of the work and the number of points of contact which one piece of work may have. It is fitting to state here that the object of the Department of Elementary Instruction is not to watch figures grow, but to add something definite and concrete, not only to the nature study and gardening work of the Borough of Brooklyn, but to the general educational movement along these lines in our country.

Ellen Eddy Shaw.